PLANTERS' BULLETIN

OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

PLANTERS' BULLETIN FORTY-SEVEN

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R R I

LOCATION. The Institute's laboratories and offices at the third mile, Ampang Road, Kuala Lumpur are open from 8 am to 1 pm and 2 pm to 4 pm on Mondays to Fridays, and from 8 am to 12.30 pm on Saturdays.

EXPERIMENT STATION AND FACTORY. This station of the R R I is situated 16 miles from Kuala Lumpur, at Sungei Buloh on the Kuala Lumpur — Kepong — Kuala Selangor road. Visits may be made on Mondays or Wednesdays by arrangement. There is a guest house.

CORRESPONDENCE. All LETTERS must be addressed to the Director, Rubber Research Institute of Malaya, Post Office Box 150, Kuala Lumpur. Special enquiries may be marked for the attention of particular officers. The address for TELEGRAMS is Searching, Kuala Lumpur. TELEPHONE: Kuala Lumpur 72051. PARCELS occasionally arrive without any indication of their origin. Senders' names and addresses should be written clearly on the outside of all packages, and advice of despatch should be given by letter or telegram.

PROHIBITED PLANT SPECIMENS. Attention of planters and others in territories outside the Federation of Malaya and the Colony of Singapore is drawn to the Malayan Plant Importation Rules which prohibit the importation into Malaya of any part of a plant, whether living or dead, unless it is accompanied by a permit issued by the Director of Agriculture, Federation of Malaya. No permit will be issued in respect of any diseased plant or any plant pest. Any plant imported in contravention of these Rules (whose object is to prevent the introduction of diseases or pests) will be destroyed without examination. Anyone outside Malaya who desires our advice on any matter that may require examination of living material must first enquire by letter.

ADVICE. Enquiries are invited from rubber producers in the Federation of Malaya, Singapore, the colony of North Borneo, and the territories of Sarawak, Brunei and Nigeria, who may require more detailed information applicable to their own special problems. Where it is considered necessary, visits will be made to estates in Malaya as convenient. Visits to estates in other territories are by special arrangement. The only visits for which charges are normally made are those of our clone indentification inspectors. INTERVIEWS should be arranged by letter, as members of the senior research and advisory staff are frequently absent on visits to plantations.

PUBLICATIONS. Subscription to all or any of our series of publications (*Planters' Bulletin, Journal, Reports*, and miscellaneous booklets) may be made by depositing $15 with us. An annual statement of account will then be submitted. We are unable to give annual subscription rates or any form of discount, but for multiple subscriptions a lower rate of initial deposit is acceptable. Postage is charged on oversea mailings. A list of 'Publications of the RRI' is available on request.

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OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

Kuala Lumpur March 1960 Number 47

Editorial: Progress

The Malayan Rubber Statistics Handbook for 1958 is now available. From the tables it contains we can try to estimate the progress of replanting and new planting throughout the country and to trace the increase in the use of high yielding material.

The total planted acreage of estates reached a maximum of 2,041,000 acres in 1953 and decreased to 97% of that figure in 1958. Probably this loss in estate acreage is due to fragmentation, and when the figure for 1959 appears it is likely to show an even greater reduction. It is surprising that up to the end of 1958 the loss was so small.

The total estate production in 1958 (390,000 tons) was higher than in previous years; the total smallholders' production (273,000 tons), remained more or less unchanged over the period 1956 to 1958. Over the same three-year period the yield per tapped acre for estates increased from 496 to 586 lb per acre per annum.

REPLANTING AND NEW PLANTING

The percentage areas planted and replanted by estates and smallholdings in recent years are shown below.

	1955	*1956*	*1957*	*1958*	*1959 (estimate)*
Estates	3.3	4.6	4.6	4.0	4.0
Smallholders*	2.2	4.0	4.1	4.7	–

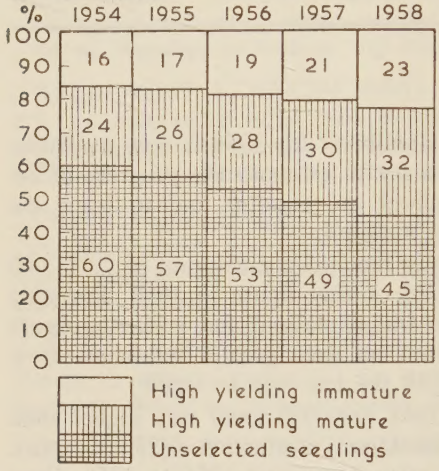
If planting continues at these rates a complete replanting of all rubber could occur within 25 years. The economic life of the tree itself can be estimated as at least 35 years, so there is little doubt that replanting on estates is making ground at the expense of obsolete rubber which is not uneconomic but could with advantage be replaced with high yielding material.

The figures for smallholders are very near to those for estates, and in 1958 the proportion of replanting and new planting on smallholdings was greater than on estates. The figures reflect credit on the various official and semi-official bodies interested in the replanting of smallholdings. It will be interesting to see whether smallholders will continue to plant more new material than estates in 1959.

* figures calculated on an estimated smallholders' acreage of 1,500,000.

HIGH YIELDING MATERIAL

The percentage of the total planted area occupied by various types of material can also be estimated, and the summarised results are shown in the Figure below. In the five years to 1958 the area under unselected seedlings decreased from 60% to 45%; in the same period the area under mature high yielding planting material increased from 24% to 32%, and that under immature high yielding planting material from 16% to 23%. The proportion of the total area under high yielding planting material, mature and immature, was only 40% in 1954 but had risen to 54% by the end of 1958. Thus in 1958 over half the area under rubber cultivation in the Federation of Malaya was planted with material which, given good husbandry, would give a high and economic rate of production.



In the Handbook there are also separate figures for the yield of high yielding material and of unselected seedlings. Both these figures show improvement. The yield of high yielding material in pounds per acre per annum in 1956, 1957, and 1958 was 781, 806 and 854. The corresponding figures for unselected seedlings were 354, 374 and 404. It is worth speculating on the specific reasons for this increase.

First, there is the possibility that 1958 was climatically a good rubber year, but on subjective evidence this would not be generally agreed. It is more likely that the increase in yield of unselected seedlings was due to the exclusion of the poorest areas from this category following clearing and replanting, and the subjection of the remaining areas to intensive tapping and yield stimulation.

The position with high yielding material is more complicated. Every year a group of 'first year of tapping' fields is added, which tends to decrease the average yield per acre. In 1956 there were 569,000 acres of high yielding mature rubber, in 1958 643,000 acres. The difference between these two figures is entirely accounted for by young rubber in its first and second year of tapping. In spite of this the average yield has increased. It seems possible that the two reasons advanced for the increase in yield of unselected seedlings are also responsible for the increase in yield of the older portion of the high yielding rubber.

The actual yield of high yielding material, given as 854 lb per acre per annum, is not very high. It seems from the figures that only 20% of the mature acreage under high yielding material yielded more than 1,000 lb per acre per annum and that only 2% yielded more than

1,200 lb per acre per annum. These figures are clearly capable of considerable improvement, which will no doubt become manifest in later years.

Finally what use is made of high yielding material by estates of the various size groups? The following Table was compiled from the 1958 Handbook:

Size group (acres)	*Total acreage planted*	*Group acreage as % of total estate acreage in Malaya*	*Percentage of group acreage occupied by:*		
			Mature unselected seedlings	*Mature high yielding material*	*Immature high yielding material*
Under 500	303,000	15	69	17	14
500–1000	217,000	11	52	27	21
1000–2000	431,000	21	43	31	25
2000–3000	271,000	14	40	35	25
3000–5000	377,000	19	40	35	25
5000 over	389,000	20	33	44	22

Clearly estates under 500 acres are lagging, while estates between 1000 to 5000 acres have speeded up replanting. As larger estates possess 10% more mature high yielding material than the 2000 to 5000 acre range, their rate of replanting is presumably slowing down so that their immature area percentage is slightly less than that of smaller estates.

It is reported in the press that Malaya has recently achieved the highest output of any country in the world. We think that these figures show how this has been accomplished, and further why the Federation of Malaya can be expected to continue to achieve high output figures in the future. While there is some way to go before areas planted with rubber achieve maximum production by the use of high yielding material, the changes over the last five years hold out great promise for the future.

Boric Acid Latex

Shipments of this type of low ammonia latex totalled 1,555,783 gallons in 1959, over two and a half times as much as in 1958. Great Britain and the rest of Europe took 41% and 56% of these shipments respectively.

Production of PA 80 (Processing Aid 80)

SP RUBBERS WERE FIRST MADE AVAILABLE in premium grades as crepe, smoked sheet and air dried sheet. Although the technical advantages of these SP rubbers have been clearly demonstrated, the economic return obtainable by their use is not always sufficient to compensate for additional costs when SP rubbers replace lower grades. Their use has consequently been mainly confined to first quality goods for which high grade rubbers must be employed.

The introduction of SP brown crepe early in 1959 provided the user with a lower grade rubber with SP properties but its usefulness is limited to the manufacture of articles which can be made from brown crepe alone.

It would be very difficult to introduce SP properties into many of the lower grade rubbers and we have sought instead to develop an SP masterbatch which the user can incorporate, to suit his own requirements, with any grade or mixture of grades of rubber, whether natural or synthetic.

We have now succeeded in preparing a suitable masterbatch called Processing Aid 80, or PA 80* for short. It is essentially an intimate mixture of 80% vulcanised rubber and 20% unvulcanised rubber and is a close relation of the present family of superior processing rubbers.

About 3 tons of PA 80 were despatched from the R.R.I. Experiment Station in the latter half of 1959 to the U.K., U.S.A., Japan, Australia, New Zealand and South Africa for evaluation in consumers' laboratories and it is already evident that a steady demand is likely to develop.

The process of production is described below for the benefit of those estates who wish to start making this new variety of SP rubber. We are now making commercial quantities at the R.R.I. Experiment Station. The procedure may be seen by appointment and the services of our staff are available to the producing industry. The process is the subject of a British Patent Application (No. 10188/57). Permission to use the process should be sought from the Board of the R.R.I.M. and will be freely granted to all *bona fide* producers on condition that samples of their production are submitted for test by the R.R.I.M. and that the total monthly output is reported.

PREPARATION OF VULCANISED LATEX

This stage of the process is common to all SP rubbers and has been described previously (*Planters' Bulletin 21*, November 1955, p. 98 and, modified slightly, in *32*, September 1957, p. 83). However the essential details are given again for completeness. The first step is the preparation of the vulcanising dispersion. The following quantities of ingredients are required per 100 lb of rubber:

* In the development stage we produced a similar substance 'SP 90' (mentioned in *Planters' Bulletin 42*, p. 71); this is now replaced by PA 80.

Sulphur	2.0 lb
Zinc oxide	0.75 lb
Zinc diethyldithiocarbamate (ZDC)	0.2 lb
Mercaptobenzthiazole (MBT)	0.4 lb
Dispersol LR	0.02 lb
Water	4.83 lb
Total	8.2 lb

The appropriate quantities of dispersing ingredients are ball-milled for 24 to 36 hours. The amount of Dispersol may require to be varied for different milling conditions.

The field latex to be vulcanised is strained, ammoniated to 0.3% and its d.r.c. determined. At the R.R.I. Experiment Station a spot determination of d.r.c. is normally carried out. A metrolac can be used to estimate d.r.c., especially if a regular source of latex is used, but in the initial period it is desirable to check the accuracy of the metrolac readings against d.r.c. determinations in the laboratory.

The correct quantity of vulcanising dispersion is added to the latex which is then heated by live steam injection, with gentle stirring, so that the temperature is raised over a period of 45 minutes to 80°C (176°F), and held there for about two hours. Completion of vulcanisation is tested by coagulating one or two millilitres of the latex with 5% formic acid and noting the condition of the coagulum. If the coagulum is partially continuous, or continuous and rubbery, vulcanisation is incomplete and further heating is required. If the coagulum is powdery and dispersible, vulcanisation is complete and the latex bulk is allowed to cool.

A sample of vulcanised latex (about 5 grams) is accurately weighed, and dried for two hours at 70°C (158°F) to determine its total solids content. Sufficient water is then mixed with the main bulk to give a final dilution of 20% total solids (T.S.).

BLENDING AND COAGULATION

Fresh field latex is diluted to 20% d.r.c. and one part by weight is thoroughly mixed with four parts of 20% T.S. vulcanised latex. The mixed latex is then coagulated with 5% sulphuric acid. Sulphuric acid is preferred to formic acid because its use apparently destroys any excess vulcanising ingredients but care is needed in the coagulation process to avoid excess of acid. About 1 pound of concentrated sulphuric acid is required per 35 lb of rubber, although there is some variation depending mainly on the amount of residual ammonia in the latex. Coagulation is rapid and the latex becomes thick with lumps of coagulum. Continuous stirring and slow addition of acid are essential. The acid is best added as a spray, and as uniformly as possible to

Figure 1. Coagulum being removed for milling. Note the lumpy appearance.

all parts of the coagulating tank. When the major part of the rubber has coagulated and some latex is still present, stirring should be continued for 10 to 15 minutes, and the liquor plus rubber then allowed to stand for a further 30 minutes. At the end of this time, the serum should be clear. If it is still milky, a little hand-squeezing of the lumps of coagulum will release occluded acid which then completes coagulation. It is convenient to leave the mixture overnight and to start milling the next day.

MILLING

Before removing PA 80 coagulum for milling, the serum is run out from the coagulating tank and replaced with clean water. After 30 minutes soaking the coagulum is milled twice between lightly grooved crepeing rolls to form a crumb which is soaked in water for about one hour and removed for drying.

DRYING

Although conventional driers have been used for the material so far produced, trials now in progress may lead to the design of more compact and economic drying equipment. The wet crumb is loaded into trays which are stacked on a drying truck and allowed to drip in the shade for about one hour before being placed in a heated crepe-drying tunnel. Wooden trays with a bottom of $\frac{3}{8}$ in. wire mesh have been used, holding between 25 to 30 lb of dry PA 80. At 100°F the drying

Figure 2. Wet milling to produce crumb.

time is 48 hours and at 120 to 130°F it is reduced to 24 hours. The optimum drying conditions are currently being investigated with particular attention to depth of crumb on the tray, number of trays per truck, circulation of air through the trays and the necessity for raking over the contents of the tray at intervals. The experience gained by larger scale production at the R.R.I. Experiment Station in the first few months of 1960 should enable us to solve these problems of detail.

Figure 3. Crumb being loaded into the drying trays.

FINISHING AND PACKING

The resultant dry PA 80 is a crumb which occupies a large bulk and is unsuitable for packing and shipment in this form. Three methods of producing PA 80 in an easily-packed form have been tried but only the third is recommended.

The first method consisted in milling the wet crumb into a thin crepe; this operation was difficult because of lack of cohesion and the resultant thin lace tore very easily and could not be hung in the conventional crepe drier.

In the second method the dried crumb is given two passes through light grooved rolls followed by one pass through smooth rolls. No water must be applied and no more than three passes used—otherwise the resultant crepe breaks up again. A gap of 0.025 in. on the smooth rolls produces a crepe of about 3 mm thickness. With a throughput of 700 lb an hour the mill rolls warm up considerably and if this method is used in practice a careful watch should be kept on the temperature of the rolls. Increasing the gap width produces a thicker crepe but

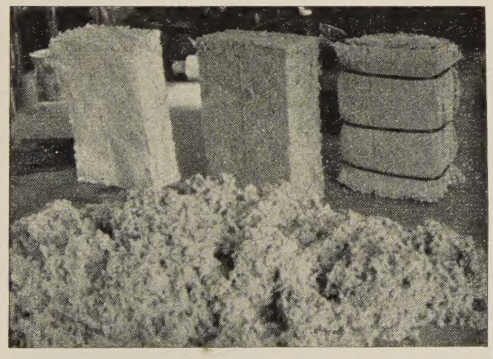


Figure 4. Loose dry crumb in foreground. The 70 lb bales are, from left to right: wet milled crepe (experimental); pressed crumb; dry milled crepe.

reduces the rise in temperature of the smooth rolls. 70 lb of PA 80 crepe are placed in a baling press to give a bale 26 in. long and 17 in. wide. The crepe is pressed to a thickness of $7\frac{1}{2}$ to $8\frac{1}{2}$ in., and clamped. The press is then released and the resultant bale is bound with three steel tapes and wrapped in polyethylene film before being inserted into a multiwall paper bag which is finally closed by staples. Although the method just described produces a finished product of conventional appearance the third procedure described below has many other advantages.

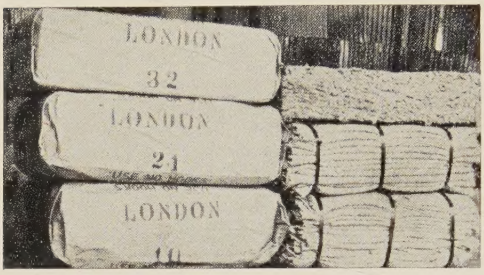


Figure 5. 70 lb bales showing from top to bottom: pressed crumb; thick dry milled crepe; thin dry milled crepe. Those on the left have been packed for export.

Our third and recommended method consists in pressing the dried crumb until it forms a coherent block which is then wrapped in polyethylene film and placed in a multiwall paper bag. The internal dimensions of the baling box are $27\frac{1}{2} \times 18 \times 12\frac{3}{4}$ in. It is not possible to compress the whole charge of crumb in one operation because of its low bulk density. Two or three additions of crumb are required, each charge being pressed in turn on top of the already pressed crumb. The final pressing should be made to give a crumb depth of 7 to 8 inches. The baling box and accessories should be faced with aluminium. Clamping bars should be located at convenient positions, and clamped together in the usual way, before the bale is finally removed from the press. The bale is left clamped overnight.

We have shipped 70 lb bales of PA 80, packed both in the form of crepe and of compressed crumb. The compressed crumb is preferred by shippers who have commented that the bales retain their rectangular shape well and are easily stacked. Compressed crumb packs more

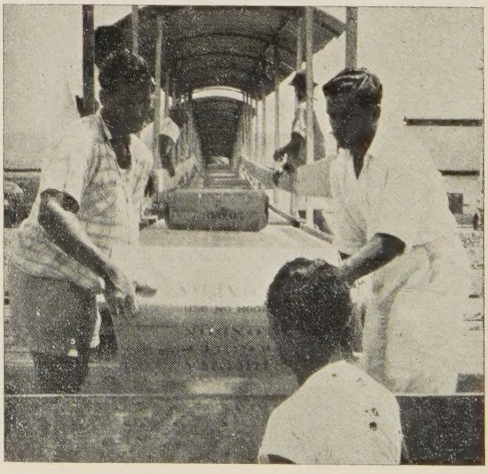


Figure 6. Bales from an experimental shipment are carried from the railway waggon to the lighter by conveyor belt at Port Swettenham. Note the neat appearance of the pressed crumb bale in the foreground.

compactly than crepe and we have found it possible to pack 100 lb in the standard multiwall paper bag. This is the method of packing PA 80 which we recommend.

COST OF PRODUCING PA 80

The additional equipment required by an estate already equipped to produce crepe is very similar to that needed for existing types of SP rubber.

The extra requirements are:

1. A ball mill
2. A supply of steam
3. A slow speed stirrer
4. A small laboratory to determine total solids and d.r.c.
5. Tanks in which vulcanisation and dilution of the vulcanised latex are carried out
6. Drying trays to fit into conventional tunnel driers
7. Minor modifications to the baling boxes

Most of this equipment is described in *Planters' Bulletin 32* and the advice of our chemical engineers is available to any estate considering production of this new type of SP rubber.

It is considered that a reasonable selling price will be 10½ to 14 cents per lb more than RSS 1 and it is at this price level that our first orders are being executed. It remains to be determined whether commercial production will confirm our assessment of a reasonable price.

Production of established grades of SP rubber has now reached a level of 3,000 tons per year. We believe that the introduction of PA 80 will enable SP properties to be incorporated into a much wider range of manufactured goods and we have every confidence that the ultimate demand for SP rubbers will considerably exceed the present output.

SP Rubber: Progress in 1959

THE TOTAL AMOUNT OF SUPERIOR PROCESSING RUBBER shipped in 1959 was 2,316 tons, more than double the figure for the previous year (1,149 tons). Shipments rose steadily to a level of 673 tons in the third quarter, but there was a slight decline in the last quarter. These shipments were made up from the various SP types as shown in the Table.

There was a steady increase in the demand for SP smoked sheet during the year, which has only just been met by existing production capacity. Plans have been made to increase this capacity early in 1960. SP crepe requirements fell off towards the end of the year. The demand for the newly introduced SP brown crepe was disappointing, largely because of the narrow price gap between RSS 1 and 2X thin brown

Quarter	*SP RSS*	*SP crepe*	*SP ADS*	*SP brown crepe*	*All types, total tonnage*
1st quarter	337	75	0	9	421
2nd quarter	387	100	7	70	564
3rd quarter	443	98	36	96	673
4th quarter	553	55	17	33	658
Total tonnage	1,720	328	60	208	2,316

crepe which persisted throughout 1959. The destination of shipments was as follows (in long tons):

Country	*1st quarter*	*2nd quarter*	*3rd quarter*	*4th quarter*	*Total 1959*
Great Britain	101.3	153.1	228.2	92.0	574.6
U.S.A.	70.3	66.5	76.0	144.0	356.8
Germany	53.3	47.7	148.9	100.0	349.9
New Zealand	45.0	100.1	60.0	142.0	347.1
Australia	43.0	84.0	49.9	48.0	224.9
Japan	36.1	47.8	61.0	65.0	209.9
France	19.0	13.8	20.0	19.2	72.0
Italy	27.5	25.0	7.0	5.0	64.5
South Africa	16.0	15.0	11.0	8.0	50.0
Belgium	–	10.0	10.5	15.0	35.5
Sweden	10.0	–	–	5.0	15.0
Malaya	–	–	–	10.0	10.0
Turkey	–	–	–	3.0	3.0
Portugal	–	–	–	2.0	2.0
Argentina	–	1.0	–	–	1.0
Algeria	–	0.3	–	–	0.3

Sixteen countries have used SP rubber and among the new-comers Malaya will be noted. An interesting feature is the important tonnages taken by New Zealand and Australia relative to their total rubber requirements. This suggests that in the larger consumer countries, Great Britain, U.S.A., Germany and Japan, there is a considerable potential market. There is clearly scope for increased usage in France, Italy and other European countries, while the U.S.S.R. and its associates have not yet considered the use of SP rubber. We believe that the demand for SP rubber will continue to increase during 1960.

Sheet Production. Rapid Drying Needs Good Machining

TO OBTAIN RAPID DRYING of sheet rubber the machining must be good. The function of the sheeting battery is to squeeze serum out of the coagulum and to thin it down. The more intense the machining the lower will be the serum content and the thinner the sheet.

Lower serum content means that less water has to be removed in the drier and thinner sheet means more rapid diffusion of water from the sheet during the lengthy last stages of drying.

The amount of serum which drips from the sheet and the rate at which it exudes also depend on the intensity of machining. This applies not only during the normal dripping period before the sheet goes into the drier, but also during the first few hours in the drier. It is nevertheless of no advantage to increase the dripping in the latter stage if the water which exudes cannot escape from the drier. If the water stays in the drier it has to be evaporated; humidity is raised and drying is retarded.

To allow the water to escape, the baffles on smokehouse trucks must slope outwards and reach beyond the rail track. The water running off the baffles must then run freely to the side channels and thence to the drains outside the drier. We recommend a 2-inch fall from the rails to the side channels and a side-channel fall towards the door of 2 inches for every 10 feet of length. In air drying sheds, with no ducts in the floor, baffles are not required but proper floor drainage including the space between the rails is still essential.

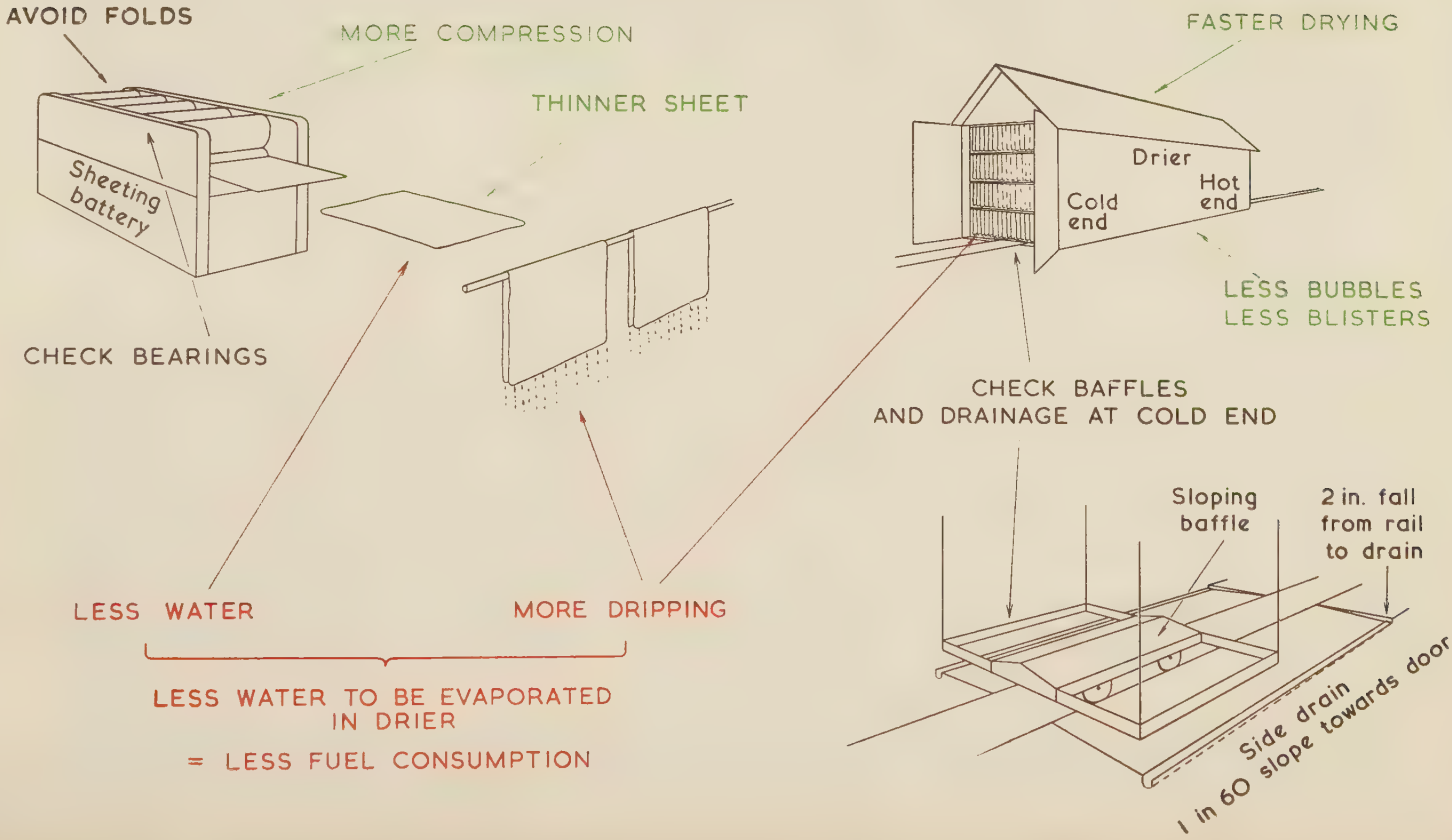
The thinner sheet produced by more intense machining is not only easier to dry—a 20% reduction in thickness reduces the drying time by about 35%—but is also less susceptible to bubble and blister formation.

More intense machining will therefore reduce the percentage of off-grades. Alternatively, if no trouble is being experienced with bubbles and blisters, it will allow a higher temperature of drying to be used which will further accelerate the drying; a 5°F rise in temperature reduces the drying time by about 10%*.

With a new battery, correctly adjusted, little can be done to improve operation of the battery itself but attention should be paid to avoiding distortion of the coagulum and folding of the sheets. It is not possible to give the exact gaps to which the rolls in a battery should be set because this varies with the design of a particular battery, and the type of coagulum being milled. However, it is almost universally accepted that the marking rolls should be tightened down until the gap is only a few thousandths of an inch. Wear on bearings and on rolls after prolonged use can therefore upset the close tolerances required for

* Readers who are interested in more detailed information on the effects of thickness, temperature, and relative humidity on drying rate are referred to the note on page 45 of this bulletin which gives details of the R.R.I. Nomograph for the Drying of Sheet Rubber.

Sheet Production: How to Improve Machining and Drying Techniques



efficient operation of this last pair of rolls. An overhaul of the bearings and re-adjustment of the rolls of a battery to give greater compression can give many advantages in the processing of sheet, and these are summarised in the diagram.

Another point to watch with marking rolls is that in the engraving of an estate name the lines should not be deeper or wider than the main grooving. Instances have been noticed where deep engraving has reduced compression and consequently permitted thickening of the sheet in the area of the name. Often the dry sheet will have bubbles only in this area — a striking example of the effect of poor compression giving rise to bubbles.

It is also clear that the factors mentioned above must be taken into account when improvements in the design of sheeting batteries are being considered.

The Nitrogen Content of Leguminous Creeping Covers

LEGUMINOUS CREEPERS are the most commonly used cover plants in the cultivation of *Hevea*. Little experimental evidence is available in Malaya concerning their effect on the growth of rubber and their popularity is based largely on visual observations of their beneficial effects on the soil and on their ability to provide a complete ground cover in a comparatively short time. They deposit on the soil surface a heavy mulch of dead leaf material. On decomposition, the mulch releases nutrients for uptake by plant roots and also favourably affects the physical characteristics of the soil. A further benefit, peculiar to legumes, lies in their ability to fix appreciable quantities of nitrogen from the soil air, this nitrogen eventually becoming available for uptake by the roots of the rubber trees. Covers of leguminous creepers are, however, expensive to establish and maintain and some planters have preferred the less costly expedient of allowing a ground cover to develop which consists largely of a mixture of grasses, often together with the non-leguminous creeper *Mikania scandens*. In some cases a 'natural' cover of mixed indigenous bushes, herbs, ferns and creepers may be encouraged to develop, but this is only possible where the proximity of uncleared land allows natural colonisation by these plants to take place.

R. R. I. M. EXPERIMENTS

In the last few years the R.R.I.M. has initiated a programme of research into the use of the different cover plants and results are now becoming available. The experiments have not been down long enough for us to determine the effects of the cover plants on tree growth and yield, but some interesting figures have been obtained on the com-

parative nitrogen status of covers of leguminous creepers, grasses, *Mikania scandens* and 'natural' covers. Typical results from two of these experiments are given in the Table.

Experiment I is a small scale experiment, using plots of one hundredth of an acre, in which the following covers are compared: leguminous creepers (a normal mixture of *Pueraria phaseoloides, Calopogonium mucunoides* and *Centrosema pubescens,*); mixed grasses (mainly *Axonopus compressus*); *Mikania scandens;* mixed indigenous bushes, ferns and creepers. This experiment is situated on a Rengam Series soil newly cleared from secondary jungle. Experiment II uses plots of one third of an acre, and compares the effects of leguminous creepers, *Mikania scandens* and mixed grasses on tree growth and yield. This experiment is in a replanted area sited on a poor alluvial sandy soil of the Sungei Buloh Series. Samples of the fresh green plant material, and of the dead leaf and stem litter under the living covers, have been taken from both experiments and analysed. In the Table the results are translated into terms of pounds per acre.

NITROGEN CONTENT

In Experiment I, after one year of growth, the 'natural' covers (a mixture of *Trema, Ficus, Macaranga, Hornstedtia* spp. and others) had produced the greatest weight of green material and litter, while *Mikania scandens* had produced the least total bulk. Determination of nitrogen contents showed that the cover of leguminous creepers contained rather more nitrogen than did the 'natural' cover, while both contained very much more than either the grass or *Mikania* covers.

The results of Experiment I are confirmed by those of Experiment II. In the latter experiment samples were taken 18 and 34 months after planting; at both samplings the cover of leguminous creepers contained far greater quantities of nitrogen than did the grass and *Mikania* covers. Of particular interest is the fact that, although the quantity of green material present in all three covers was lower in the second sampling than in the first, the quantity of litter under the leguminous creepers had increased by over 80% whilst the litter under the other two covers had actually decreased in the interval between the two samplings. Analysis shows that between the two samplings the total nitrogen content of the leguminous creeping covers (green material and litter) increased from 244 lb per acre to 320 lb per acre, while that of the grass cover stayed constant and that of the *Mikania* cover decreased. The build-up of litter and of nitrogen content has always been used as an argument in favour of the leguminous creeping covers and it is interesting to obtain this confirmation.

AVAILABILITY OF THE NITROGEN TO THE RUBBER PLANT

The carbon/nitrogen ratios of the different cover litters were also recorded in these experiments. These ratios, which range from about 14

ANALYSIS OF COVER CROPS

Experiment No.	*Time of sampling, months after planting*	*Cover*	*Wt of green material, lb/ac.*	*Wt of leaf and stem litter, lb/ac.*	*Total wt of nitrogen in green material and litter, lb/ac.*	*Carbon/nitrogen ratio* of leaf and stem litter*
I	12	Leguminous creepers	5640	4413	212	13.8
		Grasses	2025	4435	65	38.1
		Mikania scandens	2654	3081	90	21.8
		'Natural covers'	8933	5426	189	21.6
II	18	Leguminous creepers	5138	3987	244	13.6
		Grasses	1333	4168	66	35.4
		Mikania scandens	3358	4147	98	27.0
II	34	Leguminous creepers	4243	7259	320	13.4
		Grasses	1226	3870	72	30.0
		Mikania scandens	2207	2921	68	28.0

* A low ratio indicates relatively high availability of nitrogen.

for the litter under leguminous creepers to a maximum of 38 for the litter under a grass cover, are of interest in that they are a guide to the *availability* of the nitrogen to the main crop, a low ratio indicating relatively high availability.

The decomposition of organic matter added to soil is brought about by a mixed population of micro-organisms which use the oxidation of carbonaceous material as a source of energy and utilise nitrogen as a food material. In the decomposition of organic matter with a low nitrogen content and a high carbon/nitrogen ratio, the rate of development of the microbial population is limited by the low nitrogen level, and any ammonia that is released during the decomposition is immediately taken up again to serve the needs of the micro-organisms; in such a case little ammonia or nitrate nitrogen will become available for uptake by plant roots. On the other hand, in the decomposition of organic matter having a high nitrogen content and a low carbon/nitrogen ratio, an excess of ammonia over that required by the microbial population will be released; this ammonia will be nitrified by nitrifying bacteria, and both ammonium and nitrate nitrogen will become available for uptake by plant roots.

The value of the carbon/nitrogen ratio at which the two processes of ammonia release and microbial utilisation are in balance is generally considered to lie in the range 20-25. Accordingly, one would expect the litter under leguminous creepers, with a carbon/nitrogen ratio of about 14, to decompose comparatively quickly and release ammonia that will subsequently be converted to the nitrate form. Until the roots of the trees extend into the inter-row areas some of this nitrate nitrogen may be lost by leaching through the soil, but after the first year of tree growth it will be absorbed by *Hevea* roots spreading through the soil under the covers. The extremely high value of the carbon/nitrogen ratio of the grass litter will prevent the formation of appreciable amounts of ammonium or nitrate nitrogen in the top soil, and *Hevea* growing under this cover will be likely to suffer from nitrogen shortage.

SOIL FERTILITY

While a full assessment of the value of the different covers used in these two experiments, and others, must await observation of their effects on tree growth and yield, the figures quoted support the case for leguminous creeping covers. The litter mulch under the leguminous creepers, still accumulating in both experiments, will persist for some time after the legumes have been shaded out by the developing *Hevea*, and the steady release of its nitrogen content will be of considerable benefit to the tree. The extra nitrogen contained in the leguminous creeping covers of Experiment II, when compared with that contained in the grass and *Mikania* covers, is equivalent to approximately 1200 lb acre of ammonium sulphate. Too much should not be made of this direct comparison of organic nitrogen with mineral fertiliser nitrogen, for the

former is only slowly available to the tree, but appreciable differences in the effects of the two covers on soil conditions and tree growth seem likely.

The data from Experiment I show that mixed 'natural' or indigenous bush covers can also accumulate large amounts of nitrogen in their green material and dead litter. As these plants are non-leguminous and do not fix nitrogen from the soil air, all the nitrogen they contain must be obtained in direct competition with the rubber tree. Over a period of time this may not be disadvantageous to the tree, for these covers build up quite a heavy litter of organic matter which will slowly release nitrogen and other nutrients for eventual uptake by the tree. Further samplings are to be carried out so that we can check on this build-up of organic matter under the various covers, and attempt to relate it to tree performance.

Tree and Stump Poisoning

PIONEER WORK ON TREE POISONING was carried out in Malaya by the Forest Department, to find ways of disposing of unwanted jungle trees after the commercially valuable timber had been extracted. Unless killed, the undesirable species would have become dominant, leading to a progressive deterioration of the country's forest resources. At first, trees were ring-girdled without poisoning, a band of bark and sapwood about 2 — 3 inches wide being removed to a depth of roughly one inch. Trees which were resistant to this treatment were felled. Of the poisons tried, to speed up the kill and make it more certain, sodium arsenite was found to be the best. It has remained in use, being both cheap and effective. A solution of the poison is poured into a frill girdle, consisting of a single line of overlapping cuts made into the bark and sapwood.

CLEARING OLD RUBBER: TREE POISONING

Use of Sodium Arsenite

When poisoning with sodium arsenite was first used as a method of clearing old rubber for replanting, it was thought that precautions would have to be taken to prevent latex from filling the frill; but this proved to be unnecessary. It was found that a sharp and heavy axe would make a satisfactory frill, 1 — 2 inches deep, into which half a pint of a 50% solution could be poured. As dissolving 10 lb of sodium arsenite in one gallon of water gives a final volume of $1\frac{1}{2}$ gallons, the quantity of poison applied per tree was about half a pound.

Post-war experiments showed that, when the poison was applied to the newly exposed surface of the wood over a band about 8 inches wide, a tree could be killed with only two ounces of sodium arsenite. This procedure has become the standard one for poisoning old rubber trees. The bark, loosened by striking it with a hammer, is stripped off

and the poison immediately brushed on. One gallon will treat fifty trees of average girth. The solution is thickened with 6 ounces per gallon of tapioca starch, which is first made into a paste with a minimum of cold water; then boiling water is added with stirring until the resulting glutinous mass is thin enough to be poured.

Sodium arsenite moves rapidly up the tree in the outer layers of the wood vessels. It is therefore not surprising that it has been found most effective when the transpiration stream is strongest — during hot, dry weather. The same consideration explains why the poison must be applied to newly exposed wood, before the vessels have dried out and ceased to conduct. If over-deep tapping has removed the bark from parts of the stem, the poison should not be applied at this point, nor even below it, but a ring of bark should be removed from higher up. Similarly, on the few trees which fail to die and have to be re-poisoned, the second ring should be made above the first.

2,4,5-T as a Tree Poison

Though poisoning the standing trees has so many advantages as a method of clearing, sodium arsenite has the one serious drawback of being highly toxic to man and domestic animals. Great care must by taken in handling it, and its use is subject to legal restrictions.* These disadvantages led to a search for an alternative poison. The most effective material to emerge was the normal butyl ester of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) dissolved in diesel fuel oil. The same chemical acts as a yield stimulant when used at a lower strength and in a different solvent. It can be purchased as a technical grade of the ester, equivalent to 80% of the acid (10 pounds in a gallon weighing 13.2 pounds), which should be diluted before use with 19 parts of Shell Diesoline or Standard Vacuum Mobildiesel to make a 5% solution. Alternatively, the ready-diluted material can be purchased from either I.C.I. (Malaya) Ltd or Malayan Fertilisers Ltd.

Tree poisoning with 2,4,5-T. The solution is painted on to the basal 15 inches of the bark.

* *Poisons (Sodium Arsenite) Regulations, 1949*, published as *L.N. 92* in the *Legislative Supplement No. 13, Vol. II* to the *Federation of Malaya Government Gazette No. 6*, dated 7 March 1949, with amendment *L.N. 622* in the *Legislative Supplement No. 56, Vol. II* to the *Federation of Malaya Government Gazette No. 27*, dated 24 December, 1949.

For tree poisoning with 2,4,5-T the solution is painted on to the basal 15 inches of the stem. Painting has been claimed to give better results than spraying. The bark is not removed; indeed, the bark must be there for the poison to exert its full effect. Where intensive tapping, particularly upward tapping, has left the base of the trunk largely covered with a layer of rubber, this should first be scraped off. Where the bark at the base of the tree has been largely tapped away, poisoning with 2,4,5-T is not to be recommended. Furthermore, being in solution in oil, 2,4,5-T should not be applied to wet bark.

The 2,4,5-T solution should be applied generously with a broad paint brush, well wetting the bark. One gallon will treat about 90 running feet in a 15-inch band, that is, about twenty-five moderately grown trees, fifteen or even fewer old seedling trees. At about $5.00 a gallon for the diluted material, the cost per tree is thus between 20 and 30 cents, against 6 to 10 cents for sodium arsenite. The labour cost for sodium arsenite poisoning is about 7 cents per tree; application of 2,4,5-T costs only half as much, but to this must be added about 6 cents per tree if prior scraping is necessary. Though tree poisoning with 2,4,5-T costs considerably more than using sodium arsenite, it is still a relatively cheap method of clearing.

Comparison of the Two Poisons

Leaf fall starts within a month of applying sodium arsenite and is usually complete in three months on inland soils. On coastal soils, and where there is a high water table, the trees take longer to lose their leaves. Decay is from the top downwards, the branches starting to fall about six months after the leaves are shed. Defoliation following 2,4,5-T poisoning is rather slower and it is usual for the trees to refoliate, sometimes more than once, after losing their leaves. All but a few will die ultimately. The failures can best be re-poisoned with sodium arsenite. There are other differences in the effects of the two poisons. Following 2,4,5-T poisoning there is less disintegration of the tree from top, but decay of the base of the tree and the root system is more rapid. The tree comes down nearly entire and therefore does more damage to the young stand if its fall is not controlled. An advantage of 2,4,5-T poisoning is the increased yield that results, making tapping profitable for a longer period; but, if a full programme of intensive tapping has been followed prior to poisoning, there will be little yield potential left.

TREE POISONING COMPARED WITH OTHER METHODS OF CLEARING

As a method of clearing prior to replanting, poisoning the standing trees has to be compared with felling and with mechanical clearing.

Felling and Stump Poisoning

Felling and poisoning the stumps is usually preferred to poisoning the standing trees in areas where the timber is saleable as firewood and

the return from sales covers the cost of clearing. Sometimes, however, the old trees are felled, stacked and burned; more rarely stacked without burning. In all cases except the last the organic matter contained in the trees is largely lost, but both procedures overcome what is generally regarded as the chief objection to poisoning the standing trees — the damage to the young rubber trees caused by falling branches. The amount of this damage varies greatly from place to place. For obvious reasons it is worst where the old trees are large and the land is sloping. The effect of damage is least felt where unselected seed has been planted, for budding in the field a year later, and it can be minimised by felling the remains of the old stand before the seedling stocks are cut back. An alternative is to pull the larger branches down with ropes, controlling their fall.

An advantage of tree poisoning is that the clearing operation can be left nearer to the time of planting than with other methods of clearing. To avoid having the young seedlings shaded to an appreciable extent, sodium arsenite poisoning should be done at least two months before planting. It is best to allow a month longer for defoliation when poisoning with 2,4,5-T. Where the timber is to be felled and burned, about three months must be allowed for it to dry out, and the burn must of course take place before the end of the dry season. Felling must therefore be done earlier than tree poisoning.

Mechanical Clearing

With the disadvantage of being initially much more expensive, mechanical clearing also entails disturbance of the soil and its exposure to the sun and to leaching, with consequent loss of organic matter and deterioration of soil structure. Furthermore, burning the felled timber destroys what could otherwise be returned to the soil as humus. On the other hand, mechanical clearing leaves the area clean, greatly simplifying later planting operations; and, where a hard pan has formed, cultivation of the soil is advantageous.

IMPORTANCE OF STUMP POISONING

Where the old stand is cleared by felling — for firewood, or to be stacked and burned — it is essential that the stumps be poisoned. Not only does this prevent the stumps from shooting, but it is an important measure of control of root disease, ensuring their rapid decay. The value of stump poisoning for root disease control was first demonstrated in an experiment put down before the war, with sodium arsenite applied in auger holes, as was then the practice. Since then the ring-barking method of poisoning with sodium arsenite has been shown to be equally effective from the point of view of root disease control. The procedure is exactly as for trees, an eight-inch band of bark being removed from the top of the stump before applying the sodium arsenite paste. The method of poisoning with 2,4,5-T is also the same as for trees, the basal 15 inches being painted with the poison.

Stump poisoning with sodium arsenite. The cut has already been treated with creosote.

Failure to observe the precaution of poisoning stumps has been the commonest cause of severe root disease in replantings. It can lead to a most serious situation in which the cost of belated control measures becomes almost prohibitively expensive, while the alternative is to accept a progressive reduction in stand and loss of crop. The serious consequences of allowing stumps to die slowly, in which condition they are readily infected with root disease, are still not sufficiently realised. No rubber stump should be left unpoisoned in the ground.

Surface Treatment of Stumps

Recent experiments have shown that stump poisoning should be supplemented by treatment of the cut surface at the time of felling, to protect it from invasion by spores of the root disease fungi. Painting the cut with creosote is recommended. With this additional treatment, stump poisoning may be no less effective than tree poisoning in checking the spread of root disease in a replanting.

Decay of Stumps

Whatever method of clearing is employed, cover plants should be established as soon as possible to minimise the adverse effects of sun and rain on the soil. Where tree poisoning or felling is practised, early establishment of a dense creeping cover has the additional important effect of greatly hastening decay of the old timber by preventing it from drying out. Under favourable conditions the boles and lateral roots of the previous stand are reduced to humus within about five years. Even before this stage is reached, those which were diseased will have ceased to be infective. To get a disease-free replanting, therefore, it is necessary to prevent root disease from becoming established on the young stand during the critical early years while potential sources of infection on the remains of the old stand are rotting away. Once they are gone, there is no host in which the parasites can survive, provided that they are denied access to the young stand. This can be

assured by the routine measures described in the article on root disease in *Planters' Bulletin 35,* March 1958.

THINNING YOUNG RUBBER

It remains to consider the use of tree poisoning in thinning a young stand. It is good planting practice to plant a higher density than is required when the trees are brought into tapping, to allow for accidental losses and the removal of runts. Progressive thinning should be carried out from the third year as described in *Planters' Bulletin 34* January 1958. Poisoning is the most convenient method of getting rid of the unwanted trees. Either sodium arsenite or 2,4,5-T can safely be used provided the following precautions are observed.

The strength of sodium arsenite should be 5 pounds per gallon of water — half the concentration used for fully grown trees. The standing tree should be poisoned. If instead the tree is felled and the stump poisoned, there is more danger of neighbouring trees taking the poison up through root grafts.

Using 2,4,5-T the recommended concentration ($2\frac{1}{2}\%$) is again half that used for clearing old rubber. The solution should be applied to a band of bark at least a foot above ground level because, if it is allowed to come into contact with the ground, there is a danger of the roots of neighbouring trees absorbing it.

Care should be taken with both poisons to prevent spillage, which is the commonest cause of accidental poisoning of other trees in the replanting. Furthermore, poisoning should never be used after budding to get rid of surplus stocks, which should be pulled out, otherwise the poison may be taken up by the budded trees growing beside them.

Clonal Resistance to Root Disease

It is not unusual to find an individual tree, apparently quite healthy, growing in an old root-disease patch. The question arises, is it resistant to root disease? It might have escaped contact with the disease; or, more likely, it might have been a volunteer seedling which grew in the centre of the patch after the disease had died out. However, there remains the possibility of its being endowed with some degree of resistance. For two practical reasons we have refrained from investigating such cases. Firstly, we lacked a method of uniform inoculation in testing for disease resistance. Secondly, even if a seedling tree were found to be resistant, only a few of its progeny, grown from seed, might be expected to exhibit the same degree of resistance.

Both these difficulties have now been overcome. We can provide uniform disease inocula (*Planters' Bulletin 44,* page 123), and have developed a technique for propagating clones on their own roots (*Planters' Bulletin 45,* page 143). In the programme which has been embarked on, to test the susceptibility of rooted clones to root disease infection, we would welcome the assistance of

planters. If you have in your plantation an apparently resistant seedling growing in an old root-disease area, we would be grateful for permission to take budwood from it with a view to making a clone which we would later attempt to establish on its own roots for the susceptibility test.

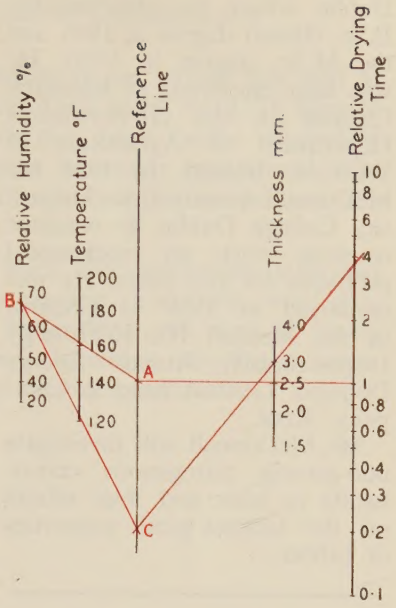
A Nomograph for Sheet Rubber Drying

It is well known that increasing the temperature, decreasing the humidity of the drying air, and reducing the thickness of the sheet all contribute to more rapid drying (*Planters' Bulletin 37* July 1958). What is not so generally realised is the magnitude of these effects.

With the aid of the nomograph, and a ruler and pencil, the effect of changes in temperature, relative humidity and thickness on the drying time between 15% and 0.7% water can be readily determined. The method is based on experiments carried out in the R.R.I. laboratories under carefully controlled conditions.

As an example of the type of problem which can be solved by the use of the nomograph, we show below how to determine the effects of temperature and sheet thickness on drying time; a 2.5 mm sheet dried at 160°F is compared with a 3 mm sheet dried at 120°F. The construction necessary for the solution of this problem is shown in the small scale illustration.

From 1.0 on the relative drying time scale a line is drawn through 2.5 mm on the thickness scale to meet the reference line at A. From A a line is drawn through 160°F on the temperature scale to meet the relative humidity scale at B. A



further line is then drawn from B through 120°F; it cuts the reference line at C. The line joining C with 3.0 mm on the thickness scale cuts the relative drying-time scale at 3.8.

Thus in this instance the 3 mm sheet will take almost four times as long to dry as the 2.5 mm sheet.

By suitable constructions the effect of any combination of temperature, humidity and thickness can be determined. More detailed information is given in a further R. R. I. publication, 'A Nomograph for the Drying of Sheet Rubber' which is issued in a convenient folder. This gives a full scale version of the nomograph together with notes on its scope and the method of use. Copies are available on request, price $2 (Malayan).

R. R. I. News

Mr J. J. McDonnell joined the staff of the Chemical Division of the Institute in January. He was trained at University College

Dublin where he obtained the B.Sc. (Hons) degree in 1948 and the M.Sc. degree in 1950. He was later employed as Research Chemist in the Government Department of Agriculture at Wexford, Ireland. In 1956 Mr McDonnell returned to University College Dublin to continue research work on biochemical problems for two years. He was employed in 1959 as Chemist in the Medical Radiobiology Department, Atomic Energy Division, General Electric Company, Kent.

Mr McDonnell will investigate non-protein nitrogenous constituents in latex and their effects on the technological properties of rubber.

Retirement of Mr C. E. T. Mann

We announce with regret the retirement on January 31st of Mr C.E.T. Mann, Director of the Rubber Research Institute of Malaya.

Mr Mann obtained his M.Sc. (London) degree at Reading University in 1924. After two years' research at the Long Ashton Agricultural and Horticultural Research Station he was appointed Plant Physiologist in the Botanical Division of the R.R.I. in 1927.

His first task at the Institute, completed by 1930, was the perfection and popularisation of the technique of bud-grafting clonal rubber. He was also concerned with the trials of clonal material, then little used in Malaya.

Mr Mann was appointed Head of the Botanical Division in 1931, soon after 'retrenchment' had led to a temporary deflection of his Division's main efforts from plant-breeding to a project of more immediate value to planters — the improvement of tapping practices. We read in the *Annual Report* of 1934 that Mr Mann had nevertheless retained faith (amply justified later) in the value of budded clonal material, despite opposition from stout believers in the 'natural seedling tree'. His Division continued to work with success until the Occupation in 1942: its work on the breeding and testing of clones and clonal seedlings, the physiology of the rubber tree, tapping systems, planting density and the use of cover crops has been of fundamental importance to the rubber producing industry.

Returning from imprisonment as a P.O.W. in Singapore, Mr Mann rejoined the Institute in 1945 and was promoted Director and Chairman of the Board in 1946. His immediate task was a difficult one. The Institute was disorganised, its records lost and its staff much diminished. Since then additional staff has been recruited and the research programme successfully reorientated to face the new demands of the post-war situation.

During Mr Mann's Directorship there have been advances in almost every sector of natural rubber research and in its application to estates and smallholdings. The industry's gratitude for his services was expressed by Mr Malcolm MacDonald in 1952, when awarding him the Colwyn Medal of the Institute of the Rubber Industry—'We salute a fine servant of the Rubber Industry. . . . Because of rubber's vital importance in the economy of Malaya, Malayans in particular are deeply in his debt'.

Our sincere good wishes go to Mr and Mrs Mann on their retirement.

Courses for Senior Estate Conductors

Refresher courses for senior estate conductors are offered this year at the R.R.I. Experiment Station during 25 April to 29 April, 16 May to 20 May, 13 June to 17 June and 4 July to 8 July. Twelve conductors can be taken on each course; they must be senior experienced men who are actually in employment, and all applications must be made by the managers of the estates concerned.

The programme will be mainly field work. Demonstrations, talks and lectures will include replanting and new planting procedures, weed control, establishment of legume covers, budgrafting and care of young budgrafts, pests and disease treatments, manuring, tapping systems, yield stimulation and a brief outline of factory procedure.

Please apply early, to the Director.

OUR COVER SHOWS CONTOUR TERRACING IN A RAVINE AREA OF A JUNGLE CLEARING AT THE R.R.I. EXPERIMENT STATION.

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